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Kikuchi

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(54) **IMAGE FORMING APPARATUS ENSURING REDUCED INITIAL BLEEDING PHENOMENON**

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G03G 15/16 (2006.01)
G03G 15/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/168*** (2013.01); ***G03G 15/80*** (2013.01); *G03G 2215/0634* (2013.01); *G03G 2215/1614* (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/168; G03G 2215/16; G03G 2215/1614
See application file for complete search history.

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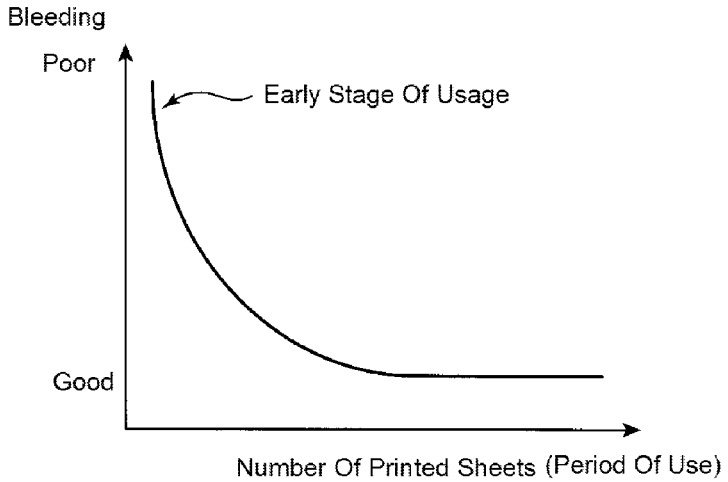
(57) **ABSTRACT**

An image forming apparatus includes an apparatus main body, a power supply switch, a photoreceptor drum, a charging device, an exposure device, a developing device, a transfer roller, a cleaning device, and a toner-layer formation unit. The transfer roller contacts the circumferential surface of the photoreceptor drum at a downstream side with respect to the developing device in the rotation direction and is configured to transfer the toner image to a sheet. The cleaning device is cleaning device arranged opposed to the photoreceptor drum, downstream. The cleaning device is configured to clean the photoreceptor drum. The toner-layer formation unit is configured to form a toner layer on a surface of the transfer roller in an initial operation started after the apparatus main body is installed in a predetermined installation location and the power supply switch is switched on.

5 Claims, 8 Drawing Sheets



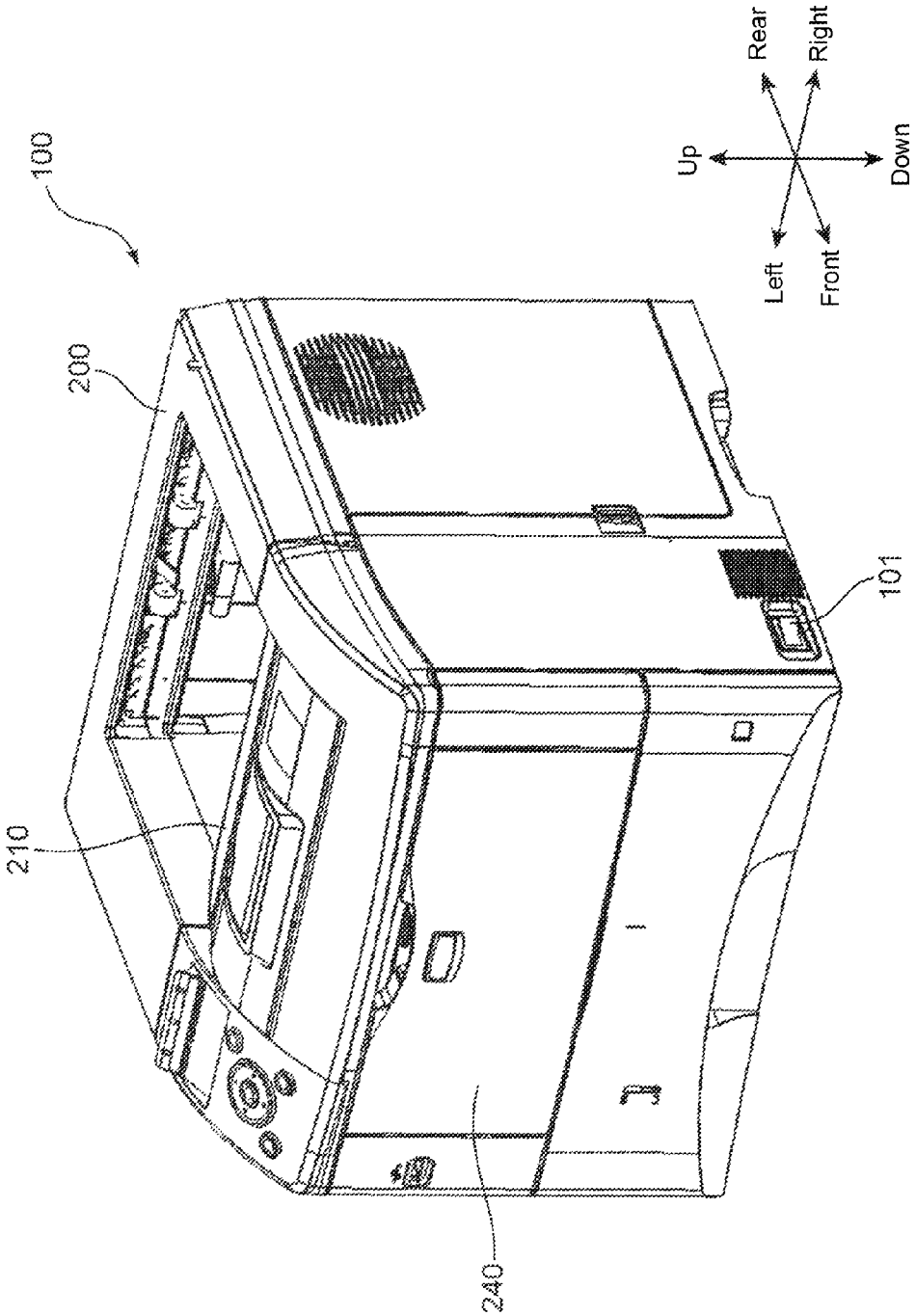


FIG. 1

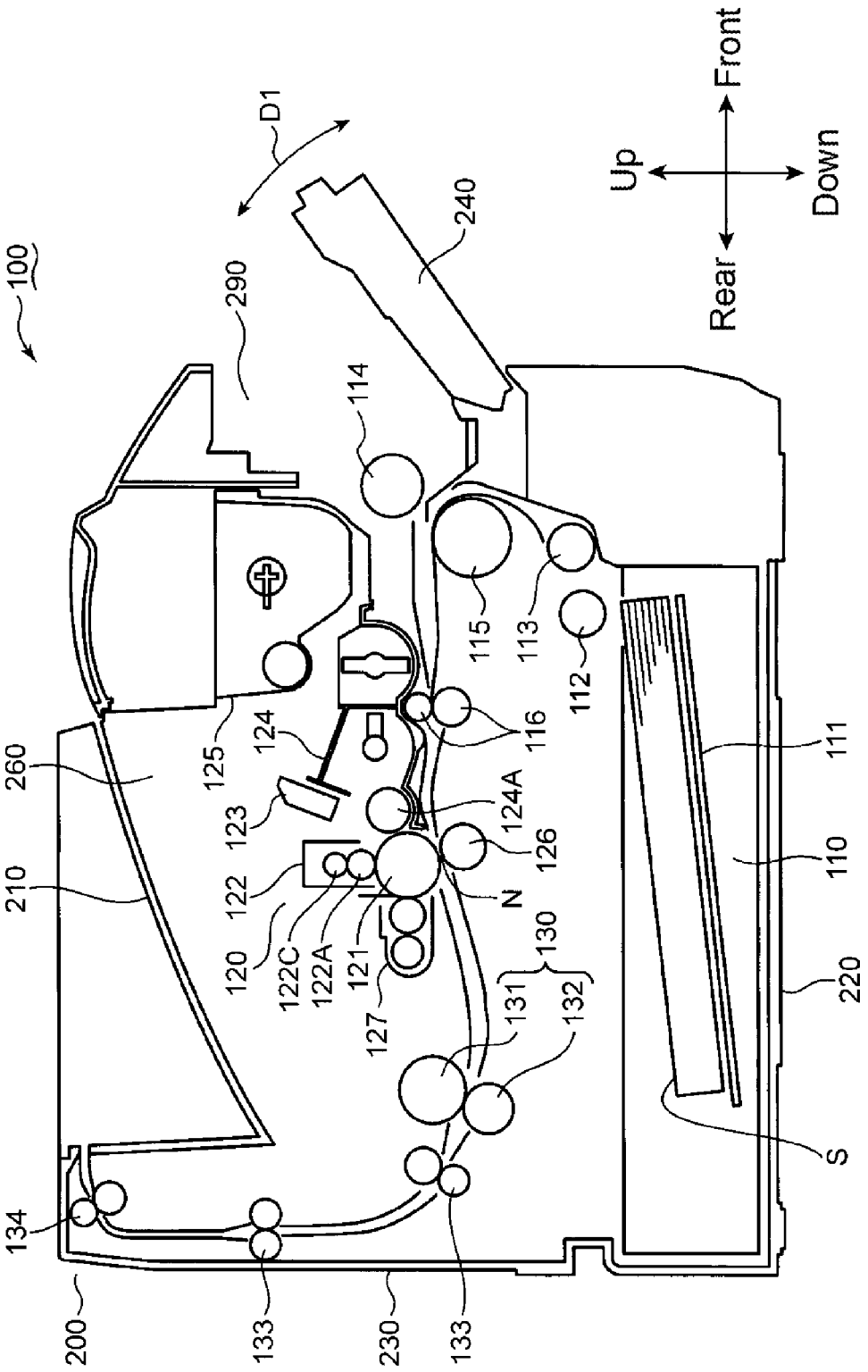

100
290
D1
240
Up
Front
Down
Rear
114
115
113
112
111
110
220
116
124A
126
125
124
123
122
120
122C
122A
121
127
130
131
132
N
S
260
210
134
200
133
230
133

FIG. 2

FIG. 3A

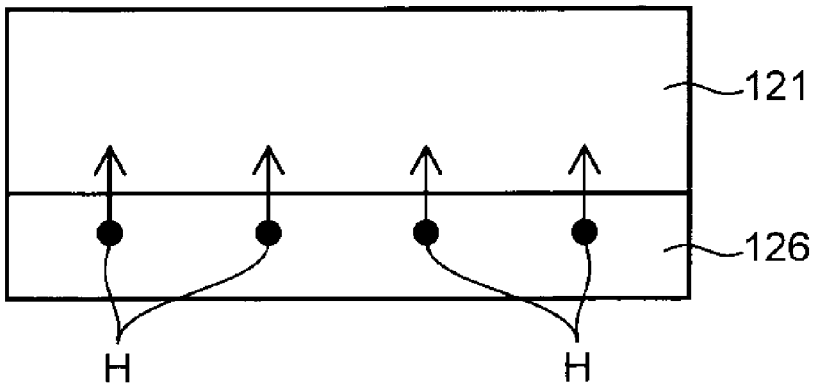


FIG. 3B

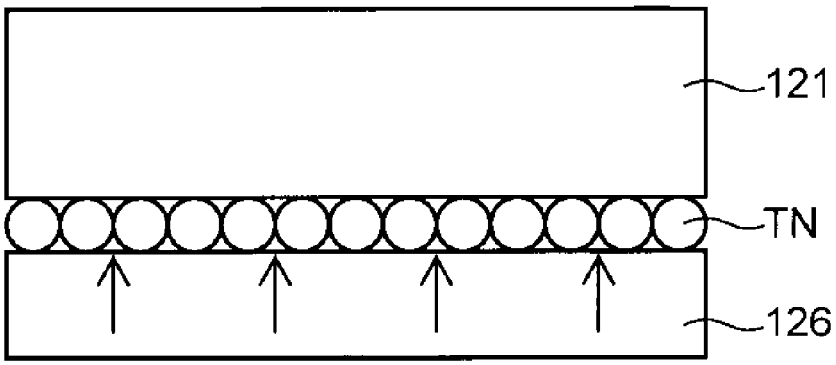


FIG. 3C

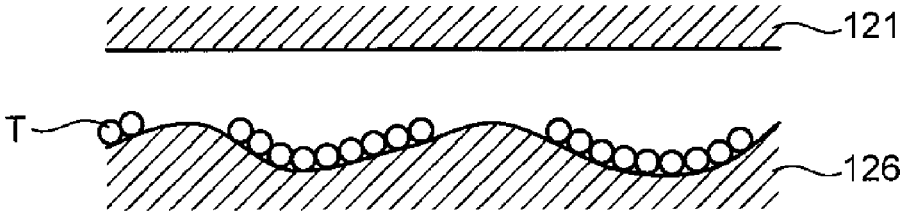
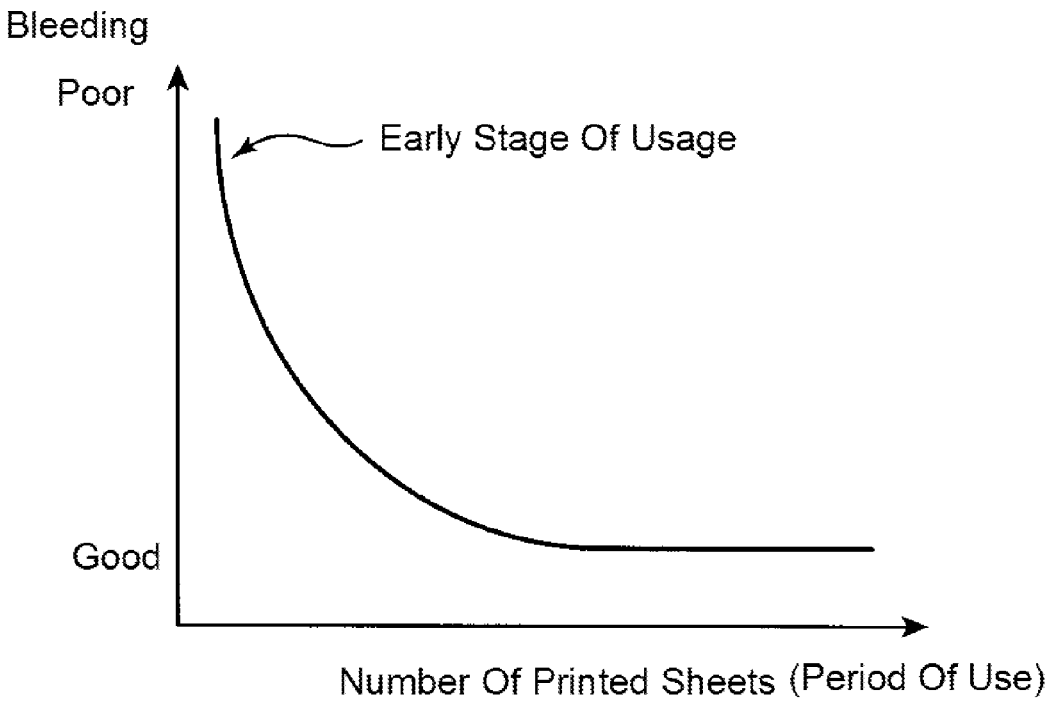


FIG. 4


Bleeding
Poor
Early Stage Of Usage
Good
Number Of Printed Sheets (Period Of Use)

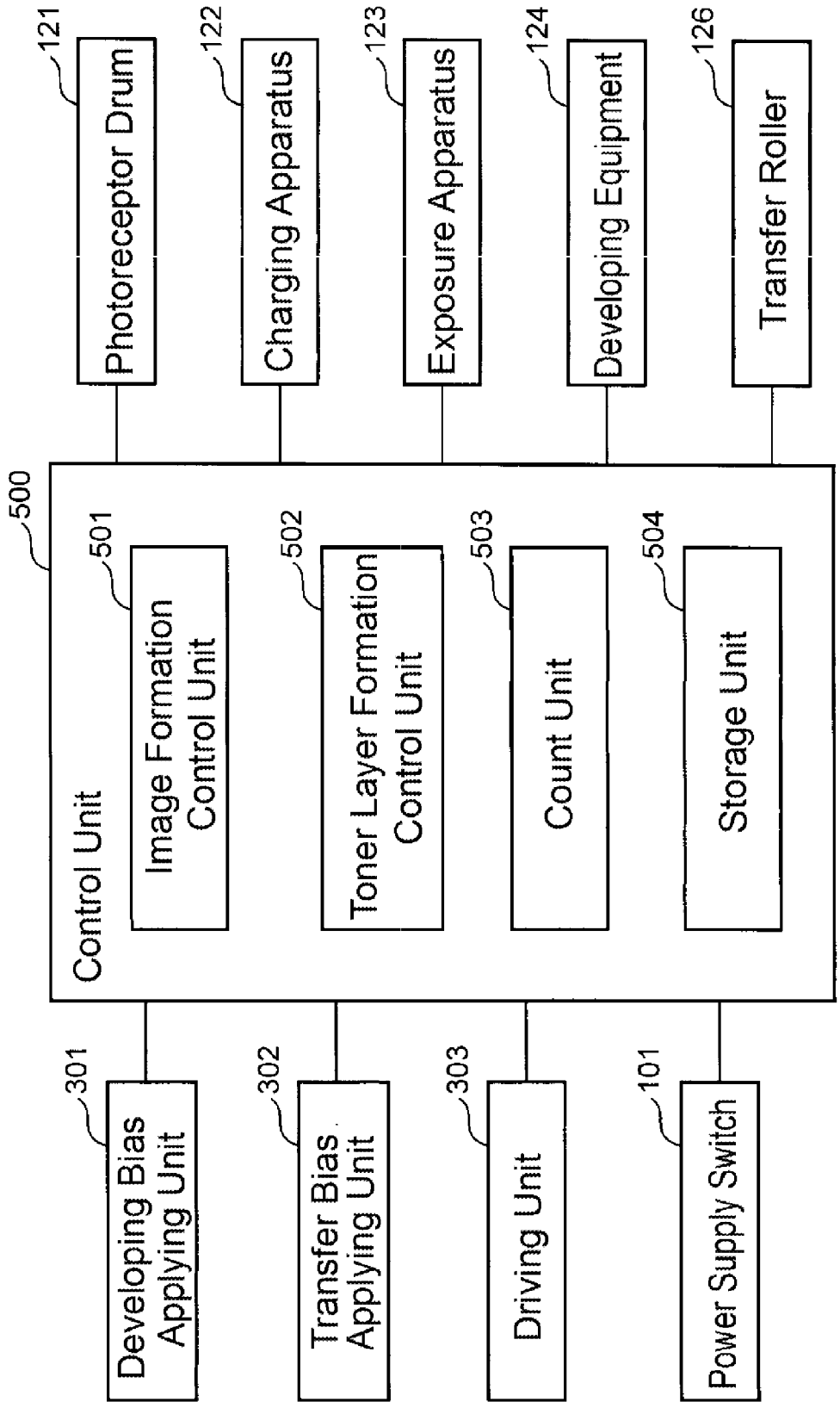

121
Photoreceptor Drum
122
Charging Apparatus
123
Exposure Apparatus
124
Developing Equipment
126
Transfer Roller
500
Control Unit
501
Image Formation Control Unit
502
Toner Layer Formation Control Unit
503
Count Unit
504
Storage Unit
301
Developing Bias Applying Unit
302
Transfer Bias Applying Unit
303
Driving Unit
101
Power Supply Switch

FIG. 5

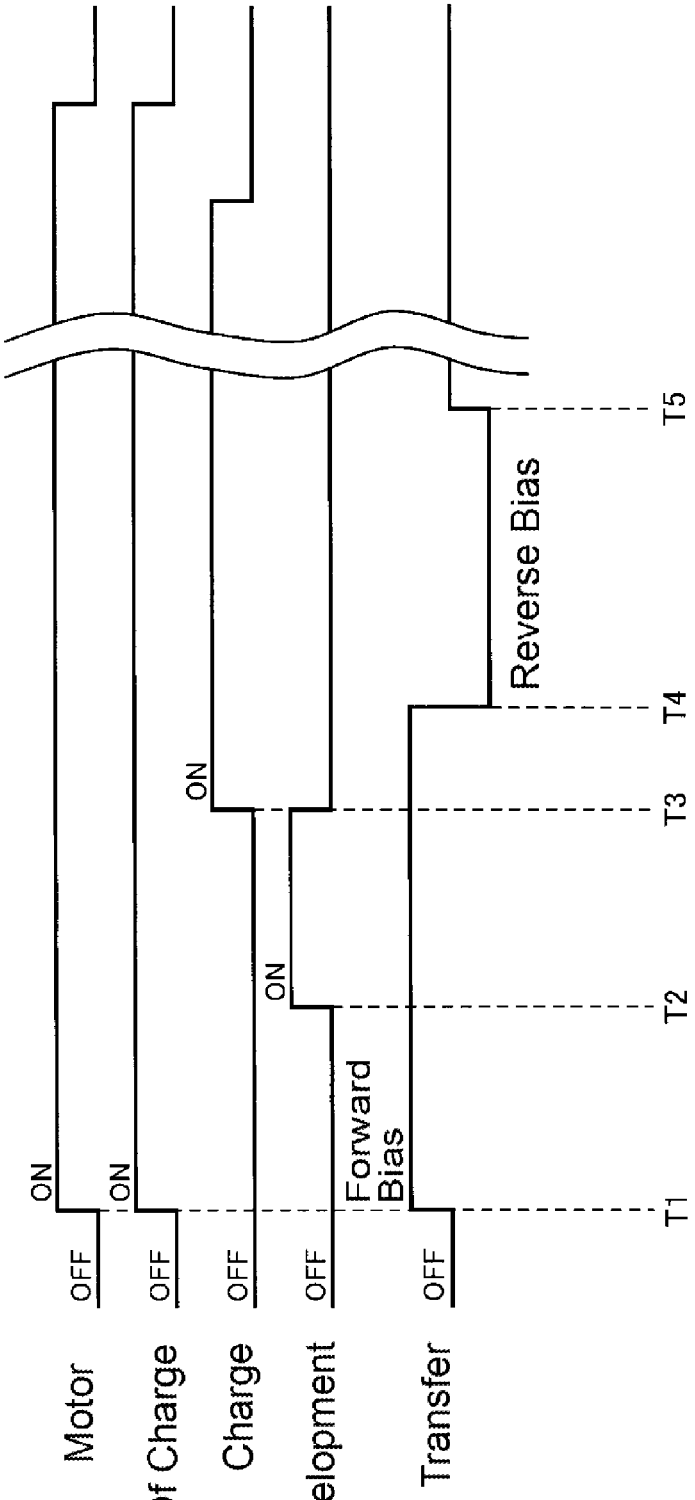

Motor
Removal Of Charge
Charge
Development
Transfer
ON
OFF
Forward Bias
Reverse Bias
T1
T2
T3
T4
T5

FIG. 6

FIG. 7A

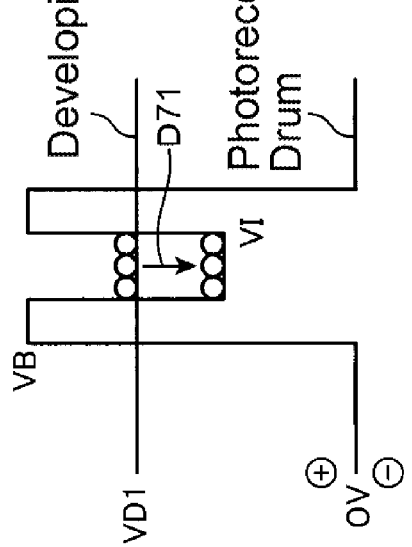


FIG. 7B

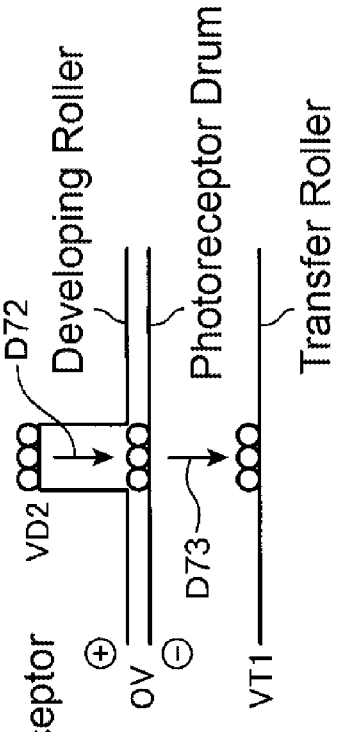


FIG. 7C

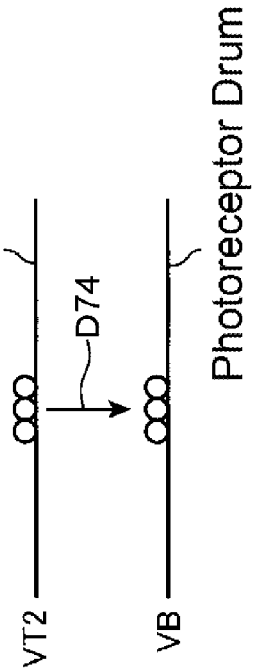


FIG. 8B

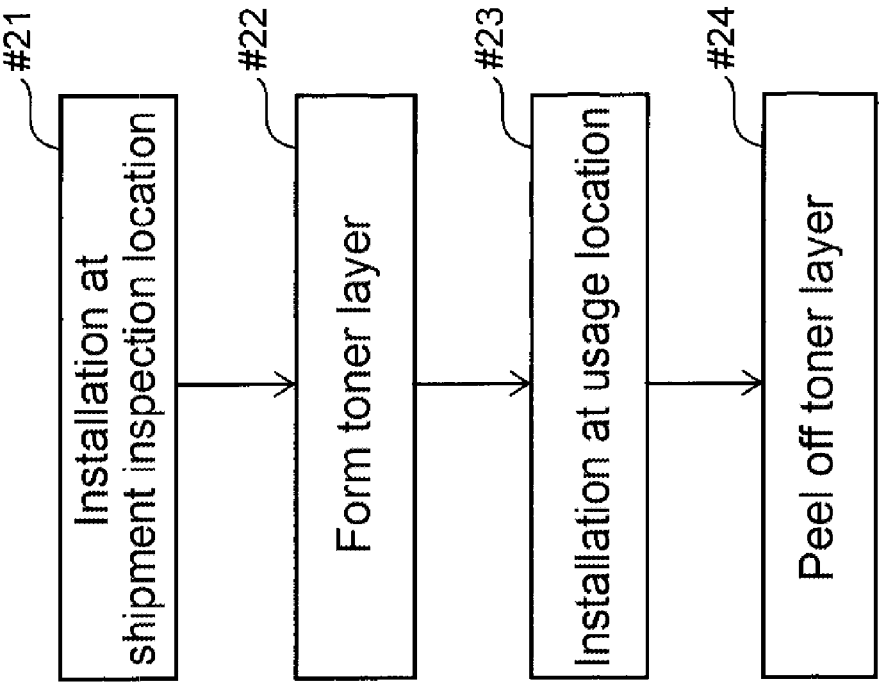

#21
Installation at shipment inspection location
#22
Form toner layer
#23
Installation at usage location
#24
Peel off toner layer

FIG. 8A

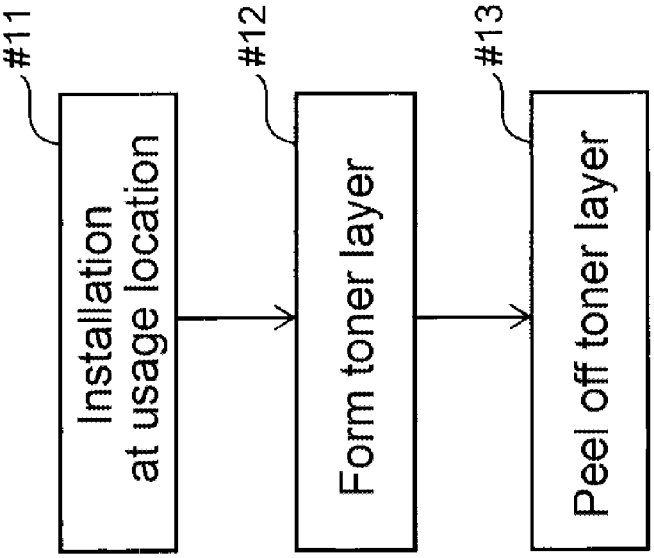

#11
Installation at usage location
#12
Form toner layer
#13
Peel off toner layer

IMAGE FORMING APPARATUS ENSURING REDUCED INITIAL BLEEDING PHENOMENON

CROSS-REFERENCE TO RELATED APPLICATION

This application is based upon, and claims the benefit of priority from, corresponding Japanese Patent Application No. 2013-200746 filed in the Japan Patent Office on Sep. 27, 2013, the entire contents of which are incorporated herein by reference.

BACKGROUND

Unless otherwise indicated herein, the description in this section is not prior art to the claims in this application and is not admitted to be prior art by inclusion in this section.

A typical image forming apparatus, which forms images on sheets, includes a photoreceptor drum, developing device, and a transfer apparatus. After the developing device visualizes an electrostatic latent image formed on the circumferential surface of the photoreceptor drum as a toner image, the transfer apparatus transfers the toner image to a sheet. The transfer apparatus includes a transfer roller. The transfer roller is in abutting contact with the photoreceptor drum and rotatably driven. Applying a transfer bias to the transfer roller forms a transfer electric field in which toner moves from the photoreceptor drum to the transfer roller.

There is disclosed a certain technique that applies a cleaning bias to a transfer roller to remove toner attached to the transfer roller made of a rubber material. The technique stops applying the cleaning bias for a predetermined period after an image forming operation is terminated to solve a bleeding phenomenon, which is a phenomenon where remaining low molecular materials (impurities) on the transfer roller exude in the form of oil.

SUMMARY

An image forming apparatus according to the disclosure includes an apparatus main body, a power supply switch, a photoreceptor drum, a charging device, an exposure device, a developing device, a transfer roller, a cleaning device, and a toner-layer formation unit. The power supply switch is arranged on the apparatus main body. The photoreceptor drum is configured to be rotatably driven in a predetermined rotational direction, wherein an electrostatic latent image is formed on a circumferential surface of the photoreceptor drum. The photoreceptor drum being configured to carry a toner image. The charging device is configured to charge the circumferential surface of the photoreceptor drum. The exposure device is configured to irradiate the circumference surface of the photoreceptor drum with an exposure light so as to form the electrostatic latent image. The developing device is arranged opposed to the photoreceptor drum, the developing device housing toner charged to a predetermined polarity, and including a developing roller configured to supply the photoreceptor drum with the toner. The transfer roller is made of an elastic material, the transfer roller contacting the circumferential surface of the photoreceptor drum downstream, in the predetermined rotational direction, of the developing device, the transfer roller being configured to transfer the toner image to a sheet. The cleaning device is arranged opposed to the photoreceptor drum, downstream, in the predetermined rotational direction, of the transfer roller, the cleaning device being configured to clean the photoreceptor drum. The toner-layer formation unit is configured to form a toner layer on a surface of the transfer roller in an initial operation started after the apparatus main body is installed in a predetermined installation location and the power supply switch is switched on.

These as well as other aspects, advantages, and alternatives will become apparent to those of ordinary skill in the art by reading the following detailed description with reference where appropriate to the accompanying drawings. Further, it should be understood that the description provided in this summary section and elsewhere in this document is intended to illustrate the claimed subject matter by way of example and not by way of limitation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** perspectively illustrates an image forming apparatus according to an embodiment of the disclosure;

FIG. **2** illustrates an internal cross section of the image forming apparatus according to the one embodiment;

FIGS. **3**A to **3**C schematically illustrate a state where a photoreceptor drum is in contact with a transfer roller according to the one embodiment;

FIG. **4** schematically describes transition of a bleeding phenomenon;

FIG. **5** illustrates an electrical configuration of the image forming apparatus according to the one embodiment;

FIG. **6** illustrates a timing chart of a toner layer formation mode of the image forming apparatus according to the one embodiment;

FIGS. **7**A to **7**C schematically describe an electric potential relationship among the photoreceptor drum, the developing device, and the transfer roller according to the one embodiment; and

FIGS. **8**A and **8**B illustrate flowcharts for describing an execution timing of the toner layer formation mode according to the one embodiment.

DETAILED DESCRIPTION

Example apparatuses are described herein. Other example embodiments or features may further be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented herein. In the following detailed description, reference is made to the accompanying drawings, which form a part thereof.

The example embodiments described herein are not meant to be limiting. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the drawings, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

Hereafter, a description will be given of one embodiment of the disclosure with reference to the drawings. FIG. **1** perspectively illustrates a printer **100** (image forming apparatus) according to one embodiment of the disclosure. FIG. **2** illustrates an internal constitution of the printer **100** illustrated in FIG. **1**. The printer **100** illustrated in FIG. **1** and FIG. **2** is a so-called black-and-white printer. However, in other embodiments, an image forming apparatus may be a color printer, a facsimile device, a multi-functional peripheral that includes these functions, or another apparatus for forming toner images on sheets. Directional terms such as "up," "down," "front," "rear," "left," and "right" are simply used for clarification of the following description without limiting principles of the image forming apparatus.

The printer **100** includes a housing **200** (apparatus main body) and a power supply switch **101**. The housing **200** houses various devices for forming images on sheets S. The housing **200** includes an upper wall **210**, a bottom wall **220**, a back side wall **230**, and a manual bypass tray **240**. The upper wall **210** specifies a top surface of the housing **200**. The bottom wall **220** specifies a bottom surface of the housing **200**. The back side wall **230** is disposed upright between the upper wall **210** and the bottom wall **220**. The manual bypass tray **240** is installed at the opposite side to the back side wall **230**. The manual bypass tray **240** is vertically turnable having its lower end as a fulcrum (arrow D1 in FIG. **2**). As illustrated in FIG. **2**, downward turning of the manual bypass tray **240** opens an opening **290** formed at the housing **200**. The opening **290** communicates with an inner space **260** of the housing **200**. Accordingly, a user can access various devices housed in the inner space **260** of the housing **200** via the opening **290**. Upward turning of the manual bypass tray **240** closes the opening **290**. Consequently, unnecessary access to the inner space **260** by the user is prevented.

The power supply switch **101** (FIG. **1**) is arranged on a lower end portion in a right-side surface of the housing **200**. When a user or a maintenance worker of the printer **100** turns on the power supply switch **101**, a predetermined voltage is applicable to the respective devices inside of the printer **100**.

The printer **100** includes a cassette **110**, a pickup roller **112**, a first feed roller **113**, a second feed roller **114**, a conveyance roller **115**, a registration roller pair **116**, and an image forming unit **120**.

The cassette **110** internally houses the sheets S. The cassette **110** includes a lift plate **111** that supports the sheets S. The lift plate **111** is inclined so as to push a leading edge of the sheets S up.

The pickup roller **112** is arranged above the leading edge of the sheets S pushed up by the lift plate **111**. Rotation of the pickup roller **112** extracts the sheet S from the cassette **110**.

The first feed roller **113** is installed at downstream of the pickup roller **112**. The first feed roller **113** sends out the sheet S to further downstream. The second feed roller **114** is installed near the fulcrum of the manual bypass tray **240**. The second feed roller **114** brings the sheet S on the manual bypass tray **240** into the housing **200**. The user can selectively use the sheets S housed in the cassette **110** or the sheets S placed on the manual bypass tray **240**.

The conveyance roller **115** is installed at downstream of the first feed roller **113** and the second feed roller **114**. The conveyance roller **115** conveys the sheet S sent out by the first feed roller **113** and the second feed roller **114** to further downstream.

The registration roller pair **116** defines a position of the sheet S in a direction perpendicular to a conveyance direction. This adjusts a position of images formed on the sheets S. The registration roller pair **116** supplies the sheet S to the image forming unit **120** according to timing of image formation by the image forming unit **120**.

The image forming unit **120** includes a photoreceptor drum **121**, a charging apparatus **122**, an exposure apparatus **123**, developing device **124**, a toner container **125**, a transfer roller **126**, a cleaning apparatus **127**, and a static eliminator (not illustrated).

The photoreceptor drum **121** has an approximately cylindrical body shape. An electrostatic latent image is formed at a circumferential surface of the photoreceptor drum **121**, and the photoreceptor drum **121** carries a toner image according to the electrostatic latent image. The photoreceptor drum **121** is rotatably driven in a predetermined rotation direction by a driving unit **303**, which will be described later. In FIG. **2**, the photoreceptor drum **121** rotates clockwise.

Application of a predetermined voltage causes the charging apparatus **122** to approximately evenly charge the circumferential surface of the photoreceptor drum **121**. The charging apparatus **122** includes a charging roller **122**A and a cleaning roller **122**C. The charging roller **122**A is rotatably driven while in contact with the circumferential surface of the photoreceptor drum **121**. With this embodiment, the charging roller **122**A is rotated driven by the photoreceptor drum **121** by a surface contact with the photoreceptor drum **121**. A charging bias applying unit (not illustrated) applies a charging bias including a DC voltage of positive polarity to the charging roller **122**A. Consequently, the circumferential surface of the photoreceptor drum **121** is charged at a predetermined surface potential VB (see FIGS. **7**A to **7**C). The cleaning roller **122**C is rotatably driven by the charging roller **122**A while in abutting contact with the surface of the charging roller **122**A. The cleaning roller **122**C cleans toner and foreign objects attached to the surface of the charging roller **122**A.

The exposure apparatus **123** irradiates the circumferential surface of the photoreceptor drum **121** charged by the charging apparatus **122** with a laser beam (exposure light). The laser beam is directed according to image data output from an external device (not illustrated) such as a personal computer communicatively connected to the printer **100**. Consequently, the electrostatic latent image corresponding to the image data is formed at the circumferential surface of the photoreceptor drum **121**.

The developing device **124** internally houses toner. The developing device **124** includes a developing roller **124**A. The developing roller **124**A is arranged opposed to the photoreceptor drum **121**. The developing roller **124**A supplies the toner to the circumferential surface of the photoreceptor drum **121** on which the electrostatic latent image has been formed. The toner container **125** supplies the developing device **124** with the toner. When the developing device **124** supplies the toner to the photoreceptor drum **121**, the electrostatic latent image formed on the circumferential surface of the photoreceptor drum **121** is developed (visualized). Consequently, a toner image is formed on the circumferential surface of the photoreceptor drum **121**. With this embodiment, the toner features characteristics of charging to a positive polarity.

The transfer roller **126** is rotatably installed so as to contact the circumferential surface of the photoreceptor drum **121**. Specifically, the transfer roller **126** contacts the circumferential surface of the photoreceptor drum **121** at a downstream side in the rotation direction of the photoreceptor drum **121** with respect to the developing device **124**, so as to transfer the toner image on the photoreceptor drum **121** to the sheet S. The transfer roller **126** is made of an elastic material. In particular, in this embodiment, the transfer roller **126** is made of a foam rubber, more specifically, ethylene propylene rubber (EPDM). When the sheet S conveyed from the registration roller pair **116** passes through a transfer nip portion N (FIG. **2**), which is located between the photoreceptor drum **121** and the transfer roller **126**, the toner image formed on the circumferential surface of the photoreceptor drum **121** is transferred to the sheet S.

The cleaning apparatus **127** is arranged opposed to the photoreceptor drum **121** at the downstream side with respect to the transfer roller **126** in the rotation direction. After the transfer of the toner image to the sheet S, the cleaning apparatus **127** cleans toner remaining on the circumferential surface of the photoreceptor drum **121**. The circumferential surface of the photoreceptor drum **121** cleaned by the cleaning

apparatus **127** again passes through downward of the charging apparatus **122** to be evenly charged. Afterwards, the above-described formation of the toner image is newly performed.

The static eliminator is arranged between the cleaning apparatus **127** and the charging apparatus **122** in the rotation direction of the photoreceptor drum **121**. The static eliminator irradiates the circumferential surface of the photoreceptor drum **121** with a charge removing light so as to diselectrify an electric charge remaining on the circumferential surface of the photoreceptor drum **121** after cleaning by the cleaning apparatus **127**. Consequently, the charging apparatus **122** further uniformly charges the circumferential surface of the photoreceptor drum **121**.

The printer **100** further includes a fixing unit **130** at a downstream side with respect to the image forming unit **120** in the conveyance direction. The fixing unit **130** fixes the toner image on the sheet S. The fixing unit **130** includes a heating roller **131** and a pressure roller **132**. The heating roller **131** melts the toner on the sheet S. The pressure roller **132** causes the sheet S to bring into close contact with the heating roller **131**. When the sheet S passes through between the heating roller **131** and the pressure roller **132**, the toner image is fixed on the sheet S.

The printer **100** further includes a plurality of conveyance roller pairs **133** and a discharge roller pair **134**. The conveyance roller pair **133** is installed at downstream of the fixing unit **130**. The discharge roller pair **134** is installed at downstream of the conveyance roller pair **133**. The conveyance roller pair **133** conveys the sheets S upward, and finally the discharge roller pair **134** discharges the sheets S from the housing **200**. The sheets S discharged from the housing **200** are stacked on the upper wall **210**.

FIGS. **3**A to **3**C schematically illustrate a state where the photoreceptor drum **121** is in contact with the transfer roller **126**. FIG. **4** is a schematically describes transition of the bleeding phenomenon of the transfer roller **126**. As described above, in this embodiment, the transfer roller **126** is made of the elastic material, more specifically, the foam rubber. In such a rubber material, the remaining low molecular material not chemically reacting during polymerization at production is partially immanent as impurities. The bleeding phenomenon where the impurities exude from the surface of the transfer roller **126** in the form of oil is likely to be a problem. With reference to FIG. **4**, the bleeding phenomenon of the transfer roller **126**, namely, exudation of the impurities decreases as the elapse of a period of use. In other words, the bleeding phenomenon is likely to be remarkable at an early stage of usage of the transfer roller **126**.

When the printer **100** is started being used and the bleeding phenomenon occurs, as illustrated in FIG. **3**A, impurities H exuded from the transfer roller **126** attach to the circumferential surface of the photoreceptor drum **121**. Since charging characteristics of a part to which the impurities attach partially changes, an electric potential at the circumferential surface of the photoreceptor drum **121** is likely to be varied. Then, the electric potential variation brings image defects such as uneven print density and a fascia. Especially, in this embodiment, a contact electrification system where the charging apparatus **122** includes the charging roller **122**A is employed. In view of this, the charge potential of the photoreceptor drum **121** by the charging roller **122**A is susceptible to a surface condition of the photoreceptor drum **121**. Accordingly, the bleeding phenomenon occurred at the early stage of usage of the printer **100** and the image defect caused by the bleeding phenomenon are problems.

To solve these problems, with this embodiment, the printer **100** includes a toner layer formation control unit **502**. Next, the following describes an electrical constitution of the printer **100** and the toner layer formation mode. FIG. **5** illustrates an electrical configuration of a control unit **500** to control an operation by the printer **100**. FIG. **6** illustrates a timing chart of the toner layer formation mode of the printer **100** according to the embodiment. FIGS. **7**A to **7**C schematically describe an electric potential relationship among the photoreceptor drum **121**, the developing roller **124**A (the developing device **124**), and the transfer roller **126**.

The printer **100** includes the control unit **500**, which controls operations of the respective units arranged inside of the housing **200**. The control unit **500** includes a Central Processing Unit (CPU), a Read Only Memory (ROM) for storing a control program, a Random Access Memory (RAM) used as a work area for the CPU, or a similar unit. By running the control program stored in the ROM by the CPU, the control unit **500** functions as an image formation control unit **501**, the toner layer formation control unit **502** (toner-layer formation unit), a count unit **503**, and a storage unit **504**. A developing bias applying unit **301**, a transfer bias applying unit **302**, and the driving unit **303** are electrically connected to the control unit **500**, in addition to the above-described power supply switch **101**, photoreceptor drum **121**, charging apparatus **122**, exposure apparatus **123**, developing device **124**, and transfer roller **126**.

The developing bias applying unit **301** applies a developing bias VD (VD1, VD2) where an AC voltage is superimposed on the DC voltage to the developing roller **124**A. The developing bias applying unit **301** is constituted of a high-voltage power supply to which a DC and an AC voltage are applicable. The developing bias applying unit **301** is controlled by the image formation control unit **501** and the toner layer formation control unit **502**, which will be described later.

The transfer bias applying unit **302** applies a transfer bias VT (VT1, VT2), which is formed of a DC voltage, to the transfer roller **126**. The transfer bias applying unit **302** is constituted of a high-voltage power supply that is able to apply a DC voltage. The transfer bias applying unit **302** is controlled by the image formation control unit **501** and the toner layer formation control unit **502**, which will be described later.

The driving unit **303** is a motor to generate a driving power for driving the respective members inside of the printer **100**. In particular, the driving unit **303** rotates the photoreceptor drum **121**, the developing roller **124**A of the developing device **124**, and the transfer roller **126** at predetermined timings.

The image formation control unit **501** integrally controls the image forming operations by the printer **100**. In the image forming operation, the image formation control unit **501** controls the charging bias applying unit (not illustrated) and applies the charging bias to the charging roller **122**A. Consequently, the surface potential VB (FIG. **7**A) of the photoreceptor drum **121** is set to 350 V. The image formation control unit **501** controls the developing bias applying unit **301** and applies a developing bias VD1 to the developing roller **124**A. In this respect, this embodiment sets a DC component of the developing bias VD1 to +250 V as an example. Further, the image formation control unit **501** controls the exposure apparatus **123** to irradiate the photoreceptor drum **121** with an exposure light corresponding to the image data. In this respect, an image electric potential VI on the photoreceptor drum **121** corresponding to an image part (solid part) with the maximum density is set to 150 V. The 100 V-difference of

electrical potential between the developing bias VD1 and the image electric potential VI on the photoreceptor drum **121** moves the toner from the developing roller **124**A to the photoreceptor drum **121** as illustrated in the arrow D**71** of FIG. **7**A, thus forming the toner image.

In the image forming operation, the image formation control unit **501** controls the transfer bias applying unit **302** and applies a transfer bias VT to the transfer roller **126**. In this respect, at a transfer timing at which the toner image is transferred from the circumferential surface of the photoreceptor drum **121** to the sheet S, a negative forward bias VT1, which has a reversed polarity of the polarity of the toner, is applied to the transfer roller **126**. The image formation control unit **501** controls the forward bias VT1 by a constant current control such that −5 μA current flows through the transfer roller **126**. The toner image is transferred from the circumferential surface of the photoreceptor drum **121** to which a positive electric potential has been set to the transfer roller **126** to which a negative electric potential has been set.

On the other hand, at an inter-sheet period corresponding to a period between the sheets S at which the plurality of sheets S pass through the transfer roller **126**, a positive reverse bias VT2, which has the same polarity as the polarity of the toner, is applied to the transfer roller **126**. The image formation control unit **501** controls the reverse bias VT2 to +500 V by the constant current control. Applying the reverse bias VT2 to the transfer roller **126** forms an electric field in which the toner moves from the transfer roller **126** to the photoreceptor drum **121**. This prevents the surface of the transfer roller **126** from being stained with the toner at the inter-sheet period. Accordingly, this reduces a back surface of the sheet S passing through the transfer roller **126** subsequent to the inter-sheet period from being stained with the toner.

The toner layer formation control unit **502** forms a toner layer on the surface of the transfer roller **126** in the initial operation started after installing the printer **100** at a predetermined installation location and turning on the power supply switch **101**. In particular, in this embodiment, the toner layer formation control unit **502** controls the developing bias applying unit **301** and provides the difference of electrical potential between the developing roller **124**A and the photoreceptor drum **121** during the initial operation. This forms a toner band having a predetermined length in the rotation direction on the circumferential surface of the photoreceptor drum **121**. Afterwards, the toner layer formation control unit **502** controls the transfer bias applying unit **302** to transfer the toner band to the surface of the transfer roller **126**, thus forming the toner layer. Details of operations by the toner layer formation control unit **502** will further be described later.

The count unit **503** counts an accumulated period of use during which the printer **100** is used after installing the printer **100** at the predetermined installation location. The count unit **503** counts the accumulated rotation time of the photoreceptor drum **121** or the number of printed sheets of the printer **100** to count information on the accumulated period of use. The storage unit **504** stores the information on the period of use counted by the count unit **503** when necessary.

The following describes the toner layer formation mode executed by the toner layer formation control unit **502** with reference to FIG. **6** and FIGS. **7**A to **7**C. As described above, the toner layer formation control unit **502** forms the toner layer on the surface of the transfer roller **126** in the initial operation started after installing the printer **100** at a predetermined installation location and turning on the power supply switch **101**. In this embodiment, the installation location means a usage installation location at which the printer **100** is used after the printer **100** is shipped from a plant. In other words, the installation location corresponds to a usage environment of the printer **100** by a customer. The initial operation includes adjustment of the respective members of the printer **100** and a setup operation for an image quality of printed images.

After installing the printer **100** at the installation location and turning on the power supply switch **101**, the toner layer formation control unit **502** executes the toner layer formation mode (see time T1 in FIG. **6**). In this respect, the toner layer formation control unit **502** controls the driving unit **303** (which corresponds to the motor in FIG. **6**) to rotatably drive the photoreceptor drum **121**, the developing roller **124**A of the developing device **124**, and the transfer roller **126**. The toner layer formation control unit **502** controls the static eliminator to irradiate the photoreceptor drum **121** with a charge removing light. Further, the toner layer formation control unit **502** controls the transfer bias applying unit **302** to apply the forward bias VT1 to the transfer roller **126** as the transfer bias VT. As illustrated in FIG. **6**, from the time T1 to time T2, the charging bias is not applied to the charging apparatus **122**. Accordingly, the surface potential of the photoreceptor drum **121** is set to 0 V.

Further, the toner layer formation control unit **502** applies the developing bias VD to the developing roller **124**A at the time T2. In this respect, the toner layer formation control unit **502** controls the developing bias applying unit **301** to apply a developing bias VD2 to the developing roller **124**A as the developing bias VD. The developing bias VD2 is set to +100 V. The 100 V-difference of electrical potential between the developing bias VD2 and the surface potential (0 V) on the photoreceptor drum **121** moves the toner from the developing roller **124**A to the photoreceptor drum **121** as illustrated in an arrow D**72** of FIG. **7**B, thus forming the toner image.

An AC bias may be further applied to the developing roller **124**A. Thus, in the toner layer formation mode, the circumferential surface of the photoreceptor drum **121** is not charged, and moreover, the circumferential surface of the photoreceptor drum **121** is not exposed by the exposure apparatus **123**. Thus, the developing bias VD (VD2) applied to the developing roller **124**A forms the toner image on the circumferential surface of the photoreceptor drum **121**.

The toner image has a predetermined width corresponding to a region that the developing roller **124**A can carry the toner in the axial direction of the photoreceptor drum **121**. The toner image has a predetermined length in the rotation direction of the photoreceptor drum **121**. Accordingly, the toner image is formed into a band shape (toner band) on the circumferential surface of the photoreceptor drum **121**.

A length LB in the rotation direction of the toner band is adjusted by a time period (from the time T1 to the time T2) at which the developing bias VD2 is applied to the developing roller **124**A. That is, assume that a peripheral velocity of the photoreceptor drum **121** is VR (mm/sec) and ΔT=T2−T1 (sec), the length LB=VR×ΔT. In this embodiment, assume that a perimetric length of the transfer roller **126** is LT (mm), T1 and T2 are preliminary set so as to meet LB>LT. In other words, the length LB of the toner band in the rotation direction on the photoreceptor drum **121** is set longer than the perimetric length LT of the transfer roller **126**.

With reference to FIG. **6**, simultaneously with ending formation of the toner band on the photoreceptor drum **121**, the toner layer formation control unit **502** controls the charging bias control unit (not illustrated) to apply the charging bias to the charging apparatus **122** (see the time T3). Consequently, the surface potential VB of the photoreceptor drum **121** is set to 350 V. On the other hand, the surface potential of the

region, which is at the circumferential surface of the photoreceptor drum **121**, at which the toner band is formed, is 0 V as described above. In view of this, up to time T4, the toner band is transferred from the photoreceptor drum **121** to the transfer roller **126** to which the forward bias VT1 has been applied (see the arrow D**73** in FIG. **7**B). In this respect, as described above, since the length LB of the toner band is set longer than the perimetric length LT of the transfer roller **126**, a toner layer TN is stably formed across the entire transfer roller **126** in the circumferential direction (FIG. **3**B). The toner layer TN adsorbs a part of impurities exuded from the surface of the transfer roller **126**.

Further, from the time T4 to time T5 in FIG. **6**, the toner layer formation control unit **502** applies the reverse bias VT2 (+500 V) to the transfer roller **126** as the transfer bias while rotating the transfer roller **126** by equal to or more than one round. Consequently, as indicated by the arrow D**74** in FIG. **7**C, the toner layer TN formed at the surface of the transfer roller **126** is reversely transferred to the photoreceptor drum **121** side. In this respect, after most toner adsorbing a part of the impurities is removed from the surface of the transfer roller **126** to the photoreceptor drum **121** side, the cleaning apparatus **127** removes the toner. Accordingly, the surface of the transfer roller **126** at which the toner layer TN is formed is cleaned. This prevents the back surface of the sheet S from being stained with the toner in subsequent image forming operations. Note that a slight amount of toner remains on the surface of the transfer roller **126** to which the reverse bias VT2 is applied due to a mechanical (superficial) adhesive force. In view of this, a protective film formed of a thin toner layer is formed on the surface of the transfer roller **126**. Consequently, the toner layer blocks the impurities, which is likely to exude at the beginning. This prevents the impurities from attaching from the transfer roller **126** to the photoreceptor drum **121** in use after the initial operation. This ensures providing the printer **100** that stably reduces the bleeding phenomenon where the impurities attach from the transfer roller **126** to the photoreceptor drum **121**. In particular, to reduce the cost of the printer **100**, even if a mechanism for evacuating the transfer roller **126** from the photoreceptor drum **121** is not provided, an image defect based on the bleeding phenomenon can be prevented.

In this embodiment, when the toner layer is formed at the transfer roller **126**, the toner band formed on the photoreceptor drum **121** is used. In view of this, using the toner housed in the developing device **124**, the toner layer can be formed on the surface of the transfer roller **126**.

In this embodiment, even if the transfer roller **126** is constituted of a foam rubber from which the impurities are likely to exude at the beginning, the toner layer blocks the impurities. As illustrated in FIG. **3**C, toner T is slightly accumulated in a concavo-convex shape at the surface of the transfer roller **126** made of the foam rubber. In view of this, shielding effect against the impurities can be continuously maintained. This prevents the impurities from attaching to the photoreceptor drum **121**.

To make additional remarks on the function of the toner layer formation control unit **502**, the toner layer formation control unit **502** has a function of forcible aging of the surface of the transfer roller **126**. That is, by attaching the toner on the surface of the transfer roller **126** where the bleeding phenomenon is initially remarkable, an extremely thin toner layer covers the surface of the transfer roller **126**. As described above, even if the toner is removed by the reverse bias after attaching the toner formed of the toner band to the surface of the transfer roller **126**, toner slightly buried on the surface of the transfer roller **126** or toner attached by mechanical adhesive force is not detached. The toner forcibly ages the transfer roller **126**, thus reducing the initial bleeding phenomenon.

The printer **100** (image forming apparatus) according to the embodiment of the disclosure is described above. However, this should not be construed in a limiting sense. For example, the disclosure can employ the following modifications.

(1) In the embodiment, an aspect where the toner layer formation control unit **502** forms the toner layer on the surface of the transfer roller **126** in the initial operation after installing the printer **100** at the predetermined installation location and turning on the power supply switch **101** is described. However, the disclosure is not limited to this. The toner layer formation control unit **502** may be an aspect that forms the toner layer on the surface of the transfer roller **126** every time the power supply switch **101** is turned on during a predetermined period after the initial operation is terminated. In this case, the count unit **503** counts, and an execution period of the toner layer formation mode is controlled based on information on the period of use stored in the storage unit **504**. As one example, until the printer **100** cumulatively prints 100 sheets, the toner layer formation mode is executed every time the power supply switch **101** is turned on. Accordingly, in the early stage of usage at which the bleeding phenomenon is likely to occur in the transfer roller **126**, the toner layers can be continuously formed at the transfer roller **126**. Accordingly, the image defect caused by the bleeding phenomenon can further be stably reduced.

(2) In the embodiment, an aspect where the toner band is formed on the photoreceptor drum **121** by the developing bias VD2 applied to the developing roller **124**A while stopping the charging operation by the charging apparatus **122** is described. However, the disclosure is not limited to this. That is, the following aspect may be employed. Similarly to an usual image forming operation, after the charging apparatus **122** charges the photoreceptor drum **121**, the exposure apparatus **123** forms an electrostatic latent image and the developing device **124** develops the electrostatic latent image. Thus, the toner band is formed.

(3) In the embodiment, an aspect where the timing of the initial operation at which the toner layer is formed at the surface of the transfer roller **126** is the timing when installing the printer **100** at the usage installation location is described. However, the disclosure is not limited to this. The installation location may be an inspection location at which a shipment inspection is conducted after producing the printer **100**. FIGS. **8**A and **8**B describe an execution timing of the toner layer formation mode.

In the previous embodiment, as illustrated in FIG. **8**A, after installing the printer **100** at the usage installation location (#11 in FIG. **8**A), the toner layer is formed at the transfer roller **126** (#12 in FIG. **8**A). Further, applying the reverse bias VT2 to the transfer roller **126** peels off the toner layer from the transfer roller **126** (#13 in FIG. **8**A).

On the other hand, in this modification, as illustrated in FIG. **8**B, when the printer **100** is installed at the inspection location (#21 in FIG. **8**B), after turning on the power supply switch **101**, the toner layer is formed on the transfer roller **126** (#22 in FIG. **8**B). Then, after performing a predetermined packing, the printer **100** is installed at the previous usage installation location (#23 in FIG. **8**B). Then, at the usage installation location, the toner layer formation control unit **502** applies the reverse bias VT2 to the transfer roller **126**, thus peeling off the toner layer from the transfer roller **126** (#24 in FIG. **8**B). That is, the toner layer formation control unit **502** applies the transfer bias (the reverse bias VT2), which has the reversed polarity of the polarity during the

transfer to the transfer roller **126**, while rotating the transfer roller **126** by equal to or more than one round at the usage installation location, thus reversely transferring the toner layer to the photoreceptor drum **121**.

With this constitution, before the user starts using the printer **100**, the bleeding phenomenon can be preliminary reduced in a shipment inspection phase. After the shipment inspection and until the printer **100** is installed at the usage installation location, even if the printer **100** is transported with the transfer roller **126** in abutting contact with the photoreceptor drum **121**, attachment of impurities from the transfer roller **126** to the photoreceptor drum **121** during the transportation is prevented. The toner layer can be peeled off from the transfer roller **126** before the user starts using the image forming apparatus. This prevents a stain at the back surface of the sheet S. As another modification, both of the formation and peeling of the toner layer of the transfer roller **126** may be performed at the inspection location.

While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

What is claimed is:

1. An image forming apparatus, comprising:

an apparatus main body;

a power supply switch arranged on the apparatus main body;

a photoreceptor drum configured to be rotatably driven in a predetermined rotational direction, wherein an electrostatic latent image is formed on a circumferential surface of the photoreceptor drum;

a charging device including a charging roller circumferentially in contact with the photoreceptor drum;

a charging bias applying unit configured to apply to the charging roller a charging bias including a positive DC voltage;

an exposure device configured to irradiate the circumferential surface of the photoreceptor drum with an exposure light so as to form the electrostatic latent image;

a developing device arranged opposed to the photoreceptor drum, the developing device housing toner charged to a predetermined polarity, and including a developing roller;

a developing bias applying unit configured to apply a predetermined developing bias to the developing roller such as to develop the electrostatic latent image on the photoreceptor drum into a toner image;

a transfer roller made of an elastic material, the transfer roller contacting the circumferential surface of the photoreceptor drum downstream, in the predetermined rotational direction, of the developing device;

a transfer bias applying unit configured to apply to the transfer roller a predetermined toner-image transfer bias of reverse polarity to the polarity of the toner so as to transfer the toner image to a sheet;

a cleaning device arranged opposed to the photoreceptor drum, downstream, in the predetermined rotational direction, of the transfer roller, the cleaning device being configured to clean the photoreceptor drum; and

a control unit, the control unit including a toner-layer formation unit, and configured to, in starting operation begun by a predetermined post-setup instance of the power supply switch being switched on, control the charging bias applying unit not to apply the charging bias to the charging roller, such that the surface potential of the photoreceptor drum will be 0 V, and at the same time control the toner-layer formation unit to

control the developing bias applying unit to provide a difference of electrical potential between the developing roller and the photoreceptor drum so as to form a toner band of predetermined length in the predetermined rotational direction on the circumferential surface of the photoreceptor drum, and

control the transfer bias applying unit to apply the predetermined toner-image transfer bias to the transfer roller so as to transfer the toner band superficially onto the transfer roller, thereby forming a toner layer on the transfer roller.

2. The image forming apparatus according to claim **1**, wherein:

a length of the toner band in the predetermined rotational direction is longer than the perimetric length of the transfer roller.

3. The image forming apparatus according to claim **1**, wherein:

the toner-layer formation unit is configured to apply to the transfer roller a transfer bias of polarity reverse to that during the transfer while rotating the transfer roller by equal to or more than one turn, so as to reversely transfer the toner layer to the photoreceptor drum after the toner layer is formed on the surface of the transfer roller.

4. The image forming apparatus according to claim **1**, wherein the transfer roller is made of foam rubber.

5. The image forming apparatus according to claim **1**, wherein:

the predetermined post-setup instance is one of every time the power supply switch is switched on during a predetermined period beginning with an initial operation of the image forming apparatus.

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